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Content English

Title: A 3D ultrasound platform to assess medial gastrocnemius lengthening during slow passive stretch in typically developing children and children with cerebral palsy.

Abstract text:

Research Question
Can ultrasound imaging combined with motion analysis be used to assess medial gastrocnemius lengthening during passive stretch in typically developing and cerebral palsy children?

Introduction
It has been reported that the medial gastrocnemius (MG) of children with spastic cerebral palsy (CPC) is shorter[1] and has reduced lengthening[2] when compared to that of typically developing children (TDC). The aim of this study was to use 2D ultrasound (US) imaging in combination with 3D motion analysis to record MG absolute and relative lengthening during passive stretch in CPC and age-matched TDC.

Materials and Methods
Five CPC (3/2 unilateral/bilateral involvement) and 5 TDC were included. Children lay prone with their upper leg strapped to the table and lower leg resting on a triangular cushion such that the knee was in slight flexion and the

ankle free. A 59mm US probe (Telemed, Lithuania) was fitted with reflective markers and tracked using motion analysis (Optitrack, USA). Muscle (medial femoral condyle to muscle tendon junction -MTJ) and tendon (MTJ to calcaneus) linear lengths were acquired at rest using the US probe as a spatial pointer. The US probe (+ markers) was then fixated above the MTJ. US images, probe orientation, ankle kinematics, kinetics, and surface electromyography (EMG) from the MG were simultaneously recorded during manually applied slow passive stretches across the full range of motion (ROM). For this study, only position and US data were analysed. Absolute MG lengthening was defined over the ROM. MG lengthening was also expressed as a percentage of the resting muscle length. The linear slope of the ankle ROM vs. relative MG lengthening graph was calculated. Parameters were compared between groups using Mann-Whitney U tests with significance at $p<0.05$.

Results

There was a general trend towards shorter muscles and reduced muscle lengthening in children with CP, although differences were not significant (Table 1).

	Age (years)	Resting muscle length (mm)	Resting tendon length (mm)	ROM (°)	Absolute muscle lengthening (mm)	Muscle lengthening relative to resting muscle length (%)	Slope of ROM vs. relative muscle lengthening graph (%/°)
TD (n=5)	8 (2)	162.7 (30.8)	169.4 (29.5)	50.7 (8.8)	23.3 (5.4)	14.3 (2.0)	0.39 (0.1)
CP (n=5)	9 (3)	153.5 (49.4)	169.8 (26.5)	40.9 (12.8)	18.7 (6.8)	12.9 (4.6)	0.41 (0.2)
p-value		0.40	0.76	0.20	0.40	0.35	0.47

Table. 1 Average (SD) parameters

Discussion

US imaging in combination with motion analysis can be used to quantify muscle lengthening in the MG during passive stretch. Obtained values are similar to those reported elsewhere.[2] The current pilot study requires a larger sample size to demonstrate significant differences between groups. Future analysis of the simultaneously acquired ankle torque will allow us to compare muscle lengthening at an equally applied torque as well as quantify MG stiffness. Assessment of MG lengthening and EMG during fast passive stretch will lend insight into the behavior of spastic muscles.

References

1. Fry et al. *Gait Posture*. 2004;20(2):177-182.
2. Matthiasdottir et al. *Clin Biomech*. 2014;29(4):458-462.

Keywords: Ultrasound, motion analysis, muscle properties, cerebral palsy, stiffness, gastrocnemius